The Open University of Sri Lanka
Diploma in Technology
ECX 3232-Electrical Power
Final Examination-2009/2010
Duration Three Hours
Date: March 02nd 2010 **Time: 0930-1230 hrs.**

This paper contains Eight (8) questions. Answer any five (5). All questions carry equal marks. Graph papers will be available on your request.

1) A 5 kVA, 2200/220V, single-phase transformer has the following parameters;

$$H.V\ side \quad r_1 = 3.4\Omega \qquad X_1 = 7.2\Omega$$
$$L.V\ side \quad r_2 = 0.028\Omega \qquad X_2 = 0.06\Omega$$

a) The transformer is made to deliver rated current at 0.8 lagging power factor, to a load connected on the L.V. side. If the load voltage is 220V, calculate the terminal voltage on the H.V. side.

b) Repeat part (a) for a load of 0.8 power factor leading

c) For a core loss of 30 Watts at rated voltage and frequency, find the efficiency under the condition of part (a) and (b).

2) The variation of load P Watts with time t (hours) in a domestic system metered at 400/230 V is given by the equation.

$$P(t) = 4000 + 38t - t^2$$

Where t is in hours over a total period of one day.

Determine:

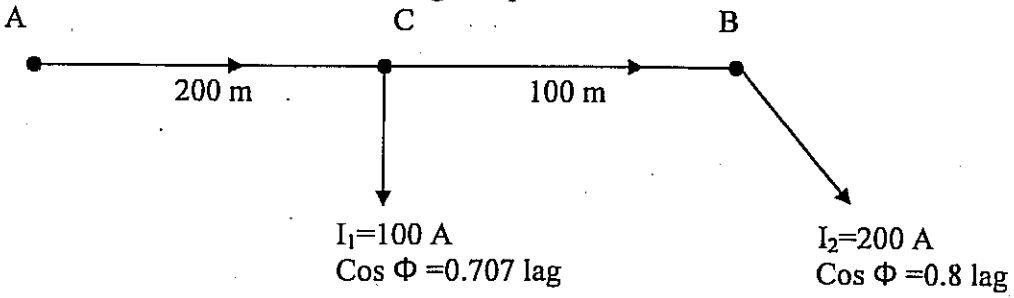
a) Energy consumed per month (1 month = 30 days)
b) Monthly electricity Bill in Rs.
c) Minimum load of the consumer
d) Maximum load and the time of the day it occurs.

(You may use the tariff table attached to this question paper)

3) A single phase a.c distributor **AB** 300 meters long is fed from end **A** and is loaded as under:

i) 100 A at 0.707 p.f. lagging 200 m from point **A**
ii) 200 A at 0.8 p.f. lagging 300 m from point **A**

The resistance and the reactance of the distributor is 0.2 Ohm and 0.1 Ohm per kilometer respectively. Calculate the total voltage drop of the distributor.



4) A 6.35 μF Capacitor is connected in parallel with a resistance of 500Ω and the combination is connected in series with a 500Ω resistor as shown in the figure Q4. The whole circuit is connected across an a.c. voltage given by

$e(t) = 300\sin\omega t + 100\,Sin(3\omega t + \pi/6)$ If $\omega = 314$ rad/s.

Find:

i) Power dissipated in the circuit
ii) An expression for the voltage across the series resistor
iii) The percentage harmonic content in the resultant current

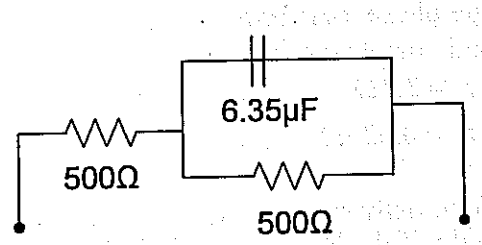


Figure Q4

5) An industrial complex installed with a generator is working at its maximum kVA capacity with a lagging power factor of 0.7. It is now required to increase the load of the complex capacity (in kW) to meet the demand of an additional load. This can be done:

a) By increasing the power factor to 0.85 lagging by p.f. correction equipment

or

b) By installing an additional generation plant costing Rs. 2400 per kVA

What is the maximum cost per kVA of power factor correction equipment to make its use more economical than the additional generating plant?

(Neglect the losses of the power factor correction equipment)

6) A d.c. series motor lifting up a load at 5 m/sec while taking 50A at 500 V from dc mains as shown in figure Q6. The total resistance of the motor is 1 Ohm. Calculate the resistance to be added in the motor circuit in order to slow the lifting speed from 5m/sec to 4 m/sec.

Assume that the electro magnetic power developed by the motor is equal to the power requiring to lifting up the load.

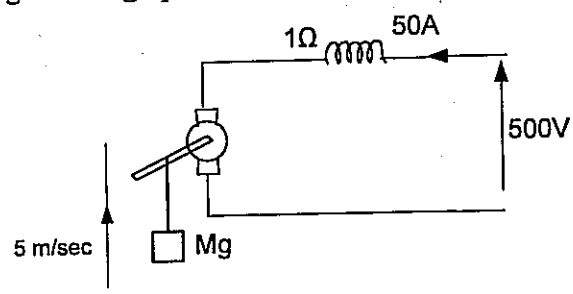


Figure Q6

7) A 20 kW, 6 pole, 400V, 50 Hz 3ϕ induction motor has a full load slip of 0.02. If the torque lost in mechanical (friction & windage) losses is equivalent to 20 Nm, Compute:

1) The mechanical torque available on the shaft
2) Electrical torque available on the shaft
3) Rotor ohmic loss (P_{cu})
4) Air gap power (P_{ag})
5) Motor input power
6) Motor input efficiency

Assume that the total stator loss is 900 watts.

8) a) Give the standard symbols used for each of the following electrical component

- Socket Outlet
- Switched Socket Outlet
- Intermediate Switch
- Lighting Outer Position
- Fluorescent Luminaire
- Two way switch
- Distribution Board
- Main Switch
- Bell Push

b) Draw a single line diagram for an industrial fluorescent circuit (with two tubes installed in parallel) showing the connection of all the associated equipment such as starter. Choke coil, tube holders, capacitors etc. What is the purpose of having a starter? Why the two tubes are installed in parallel?

Tariff table for Q2

Customer Category	Conditions	Maximum demand charge Rs./kVA per month	Energy Charge Rs./kwh	Fixed Charge Rs./month
Domestic	Metered at 400V/230V	-	1-30 Units @ 3.00 31-60 Units @ 4.70 61-90 Units @ 5.10 91-180 Units @ 12.10 Above 180 Units @ 17.30	60.00 90.00 120.00 180.00 240.00
Religious	Metered at 400V/230V	-	1-30 Units @ 2.50 31-90 Units @ 3.70 91-180 Units @ 5.50 Above 180 Units @ 8.70	60.00 90.00 180.00 240.00
General Purpose All buildings except industries & some hotels	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	 11.90 11.90	 240.00 500.00
	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	480.00 460.00	11.80 11.70	3000.00 3000.00
Industrial	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	 8.50 8.50	 240.00 500.00
	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	400.00 380.00	8.10 8.00	3000.00 3000.00
Industrial **(Time Of Day)** Includes some hotels	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	 16.00 bet 7-10 p.m. 7.90 at other times	 240.00 500.00
	Metered at 400V/230V contract demand > or = 42 kVA	380.00	22.00 bet 7-10 p.m. 7.50 at other times	3000.00
	Metered at 11/33/132 kV contract demand > or = 42 kVA	360.00	20.00 bet 7-10 p.m. 7.10 at other times	3000.00
Hotels(GP)	Metered at 400V/230V contract demand > or = 42 kVA	480.00	11.80	3000.00
Hotels(Industry)	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	480.00 380.00	8.10 8.00	3000.00 3000.00
Hotels **(Time of day)**	contract demand > or = 42 kVA Metered at 400V/230V	380.00	22.00 bet 7-10 p.m. 7.50 at other times	3000.00
	Metered at 11/33/132 kV	360.00	20.00 bet 7-10 p.m. 7.10 at other times	3000.00
Supplies to licensees LECO/LA	Supply at 400/230 V Supply at 11k V & above	240.00 220.00	8.80 6.90	